VOLUME THREE

UPDATED WSMP

DEIS/EIR

TECHNICAL APPENDICES B1-B2

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VOLUME THREE

Draft Environmental Impact Statement/Report

Updated Water Supply Management Program

TECHNICAL APPENDICES B1-B2

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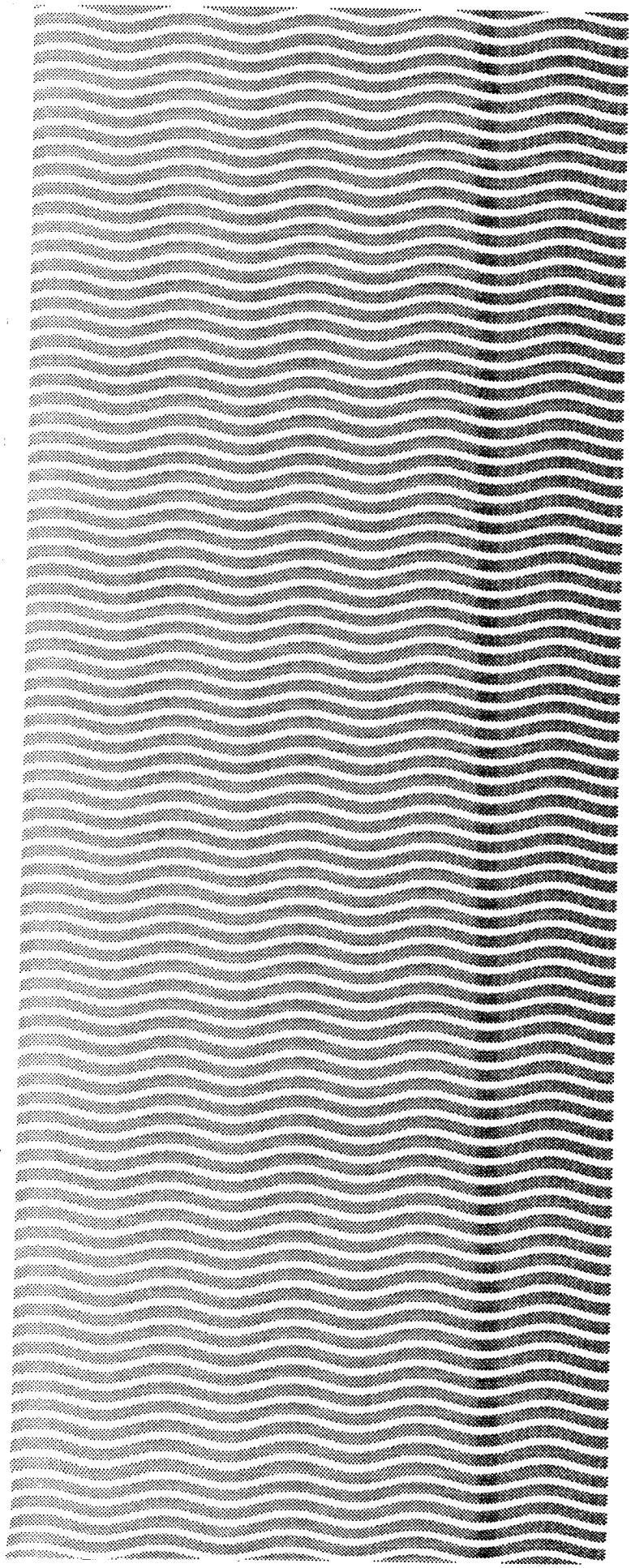

VOLUME THREE

Draft Environmental Impact Statement/Report

Updated Water Supply Management Program

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ACKNOWLEDGEMENTS

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PROJECT DATA

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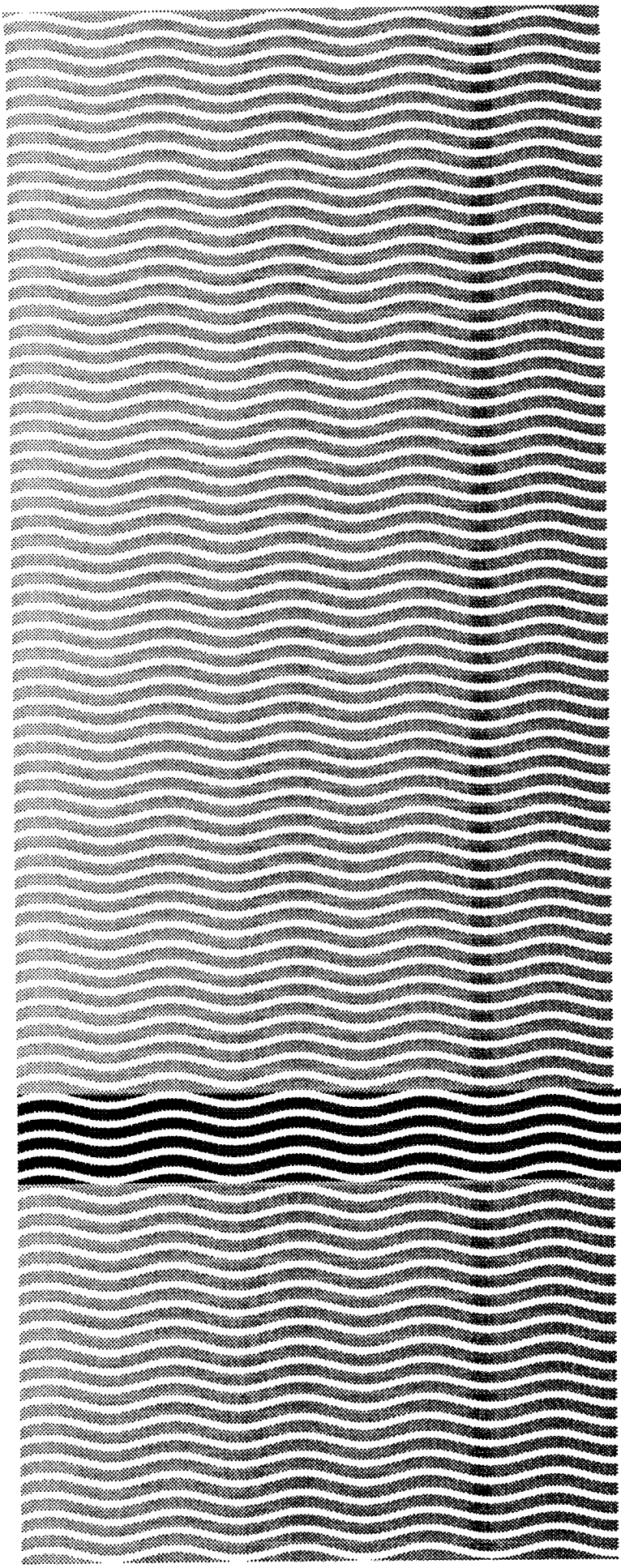

WSMP

TECHNICAL APPENDIX B1 Lower Mokelumne River Management Plan (LMRMP)

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LOWER MOKELUMNE RIVER MANAGEMENT PLAN

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LIST OF ACRONYMS

af	acre-feet
ARIMA	autoregressive integrated moving average
CDFG	California Department of Fish and Game
cfs	cubic feet per second
COE	U.S Army Corps of Engineers
CRWQCB	California Regional Water Quality Control Board
CVP	Central Valley Project
CVRWQCB	Central Valley Regional Water Quality Control Board
CWT	coded wire tag
DWR	California Department of Water Resources
EBMUD	East Bay Municipal Utiliites District
EBMUDSIM	EBMUD's hydrological simulation model
EPA	Environmental Protection Agency
ESY	economic sustainable yield
FL	fork length
ha	hectares
IFIM	Instream Flow Incremental Methodology
LMRMP	Lower Mokelumne River Management Plan
MRFH	Mokelumne River Fish Hatchery
MSY	maximum sustainable yield
NTU	nephelometric turbidity units
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
NSJWCD	North San Joaquin Water Conservation District
OSY	optimum sustainable yield
PG&E	Pacific Gas and Electric
ppm	parts per million
SCIES	Stream Corridor Inventory Evaluation System
SJCHD	San Joaquin County Health District
SWP	State Water Project
SWRCB	State Water Resources Control Board
TAF	thousand acre-feet
TL	total length
TNF	true natural flow
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
WID	Woodbridge Irrigation District
WSMP	Water Supply Management Plan
WUA	weighted usable area

GLOSSARY OF TERMS

Acre-foot (af): The volume of water required to cover an acre one foot deep. Equal to 325,800 gallons or 43,560 cubic feet of water.

Alevin: Fish fry, particularly salmonids, on which the yolk sac is still apparent.

Anadromous: Life history pattern in which a fish spawns in fresh water and the offspring migrate to saline waters to mature.

Armoring: The formation of an erosion-resistant layer on the surface of the stream bed which resists degradation by water currents and may be unsuitable for spawning.

Attraction flows: Large water releases intended to stimulate upstream salmonid migration. These releases may aid in orientation and passage during migration.

Carriage water: Delta outflow required to compensate for the hydraulic effects of Delta exports on Delta circulation and, thus, water quality standards, or flow required in channel to provide adequate head for water delivery.

CDFG Plan: The plan for operations and other management proposed by CDFG for the Lower Mokelumne River.

Coded wire tagging: A method of internally marking fish by injecting a small piece of wire into the fish's head. The wire is encoded with a unique number which is used, upon recovery, to determine the river of origin.

Critical dry water year: For the LMRMP, a critical dry water year occurs when Pardee and Camanche storage is more than 250,000 acre-feet below that allowed by COE flood control rules.

Cubic feet per second (cfs): A rate of flow. One cfs is equal to 0.265 acre-feet per day.

Downstream beneficial uses: Valued water uses downstream of a specified point. Beneficial water uses are recognized by state law.

Dry water year: For the CDFG plan, a dry year occurs when annual unimpaired inflow into Pardee Reservoir is less than 50 percent of the historical average. For the LMRMP, dry year releases are made if the storage on 5 November in Pardee and Camanche reservoirs is below (but by no more than 250,000 acre-feet) that allowed by COE flood control rules.

Emergence: The act of alevin leaving the gravel of the redd and entering the river to rear.

Entrapment zone: An area in an estuary where fresh and salt water mix. The specific location varies with freshwater outflow.

Epilimnion: The upper, warm water zone in a thermally stratified impoundment.

Escapement: The total number of adult salmon that successfully migrate upstream to spawn.

Fall-run chinook: A race of chinook salmon in which the adults migrate upstream in the fall, spawn in the fall and winter, fry emerge in the winter or spring, and juveniles migrate downstream in the spring or summer.

Fall turnover: When the upper layer of a stratified lake cools in the fall to become as heavy as lower layers, and the water mixes. Also known as destratification.

Fines: Small particles of sediment, as in suspended mud, silt, or sand.

Flow strategies: Methods of managing flow levels using upstream reservoir releases.

Fry: A general term for any young fish.

Grilse: see Jack

Habitat: The part of the physical environment in which a plant or animal lives.

Hypolimnion: The part of a lake below the thermocline made up of water that is stagnant and of uniform temperature except during turnover; the lower, cool water zone in a thermally stratified impoundment.

Jack A two year old salmon.

In-migration: The upstream spawning migration of adult anadromous fish.

Lower Mokelumne River Management Plan (LMRMP): The plan for operations management developed by BioSystems and EBMUD for the Lower Mokelumne River, also the preferred plan.

Metalimnion: The stratum between the epilimnion and the hypolimnion of a stratified reservoir which exhibits a marked thermal discontinuity.

Migration: To pass periodically from one region to another for feeding or breeding.

Minimum flows: A mandated flow level having priority over all other flow levels, except as may be specifically allowed.

Natural production alternative: The LMRMP.

Non-flow alternatives: Measures to improve survival or otherwise increase production of salmon using technology or methods that do not change water releases from upstream reservoirs.

Normal water year: For the CDFG Plan, annual unimpaired inflow into Pardee Reservoir is between 50 and 110 percent of historical inflow for the LMRMP. A normal water year occurs when Pardee and Camanche 5 November storage is at or above levels allowed by the COE.

Out-migration: The downstream movement of smolts or fry to the estuary or ocean.

Real-time management: Management in response to actual and immediate conditions.

Rearing: For salmon, the life stage between emergence and out-migration.

Redd: Spawning site or nest of salmon or trout.

Riparian: Relating to or living or located on the bank of a natural watercourse.

Smolt: A stage in anadromous salmonid development when juveniles are physiologically and behaviorally capable of migrating into saline waters.

Spawn: The act of egg laying and external fertilization in fish.

Spring-run chinook: A race of chinook salmon in which the adults migrate upstream in the spring, spawn in the fall, and juveniles migrate downstream in the spring.

Steelhead: The anadromous form of rainbow trout.

Thermal refugia: Cool microhabitats in a river used by fry and smolts to avoid unfavorably hot conditions.

Thermocline: Plane or surface of maximum rate of decrease of temperature with respect to depth.

Warmwater fish: Fish species that favor warm water.

Water year: A year delimited by a dry period; typically, October 1 to September 30.

Wet water year: By CDFG criteria, a year with unimpaired inflow to Pardee Reservoir in excess of 110 percent of the historical average.

Yearling: In salmonids, the life-stage during juvenile development that occurs 12 months after spawning through 24 months after spawning.

ACKNOWLEDGEMENTS

This report was written by BioSystems Analysis, Inc. (BioSystems) of Tiburon, California, the East Bay Municipal Utility District (EBMUD), Fish Pro, Inc. of Portland, Oregon (Section 5.3) and David Vogel of CH2M HILL, INC. (Appendix G). EBMUD had primary responsibility for reservoir operations and reservoir non-flow alternatives. The report was edited by BioSystems and EBMUD, and was produced by BioSystems.

EXECUTIVE SUMMARY

BACKGROUND

The Lower Mokelumne River flows from Camanche Dam to the Delta of the Sacramento and San Joaquin rivers (the Delta). The river supports several introduced and native fishes including chinook salmon and steelhead trout. Salmon and steelhead trout runs throughout the Central Valley have been drastically reduced from historical levels as the result of overharvesting, habitat loss, water diversions, and water quality changes. Figure 1 shows Mokelumne River salmon spawning stocks and important environmental events of the last half-century.

East Bay Municipal Utility District (EBMUD) built Pardee Reservoir in 1928 and Camanche Reservoir in 1964 for water supply and flood control purposes. EBMUD diverts water from Pardee Reservoir to supply water to its customers in 20 cities and two counties in the East Bay region of the San Francisco Bay Area. Other uses of the reservoirs include hydroelectric power, recreation, and regulation for downstream irrigation users.

Although operation of the reservoirs has affected chinook salmon and steelhead trout habitat by eliminating spawning habitat and changing downstream hydrology and water quality, other factors influencing fish populations such as ocean harvest and conditions in the Delta and San Francisco Bay are outside of EBMUD's control. Prior to the construction of EBMUD's reservoirs, Woodbridge Dam interrupted in-migration from 1910-1940. Loss of spawning habitat caused by the construction of Camanche Reservoir was to be mitigated by EBMUD's construction of the Mokelumne River Fish Hatchery (MRFH) and implementation of the 1961 operating agreement with the California Department of Fish and Game (CDFG). During drought, periodic fish losses have occurred at the hatchery.

Since the onset of the current drought in 1987, and consistent with historical drought conditions, chinook salmon escapement has declined. In 1990, EBMUD and the CDFG reached an interim agreement to increase the water supply released for the fishery under protracted drought. As drought continued in 1991, a second interim agreement was implemented that increased releases for the fishery.

The Lower Mokelumne River Management Plan (LMRMP) was developed for EBMUD as an important component of the updated Water Supply Management Program (WSMP) and is incorporated into all Composite Programs. The purpose of the LMRMP is to:

- Document EBMUD's commitment to protecting public trust resources.
- Contribute to developing EBMUD's definition of its need for water.
- Balance EBMUD's water supply needs with in-river needs.

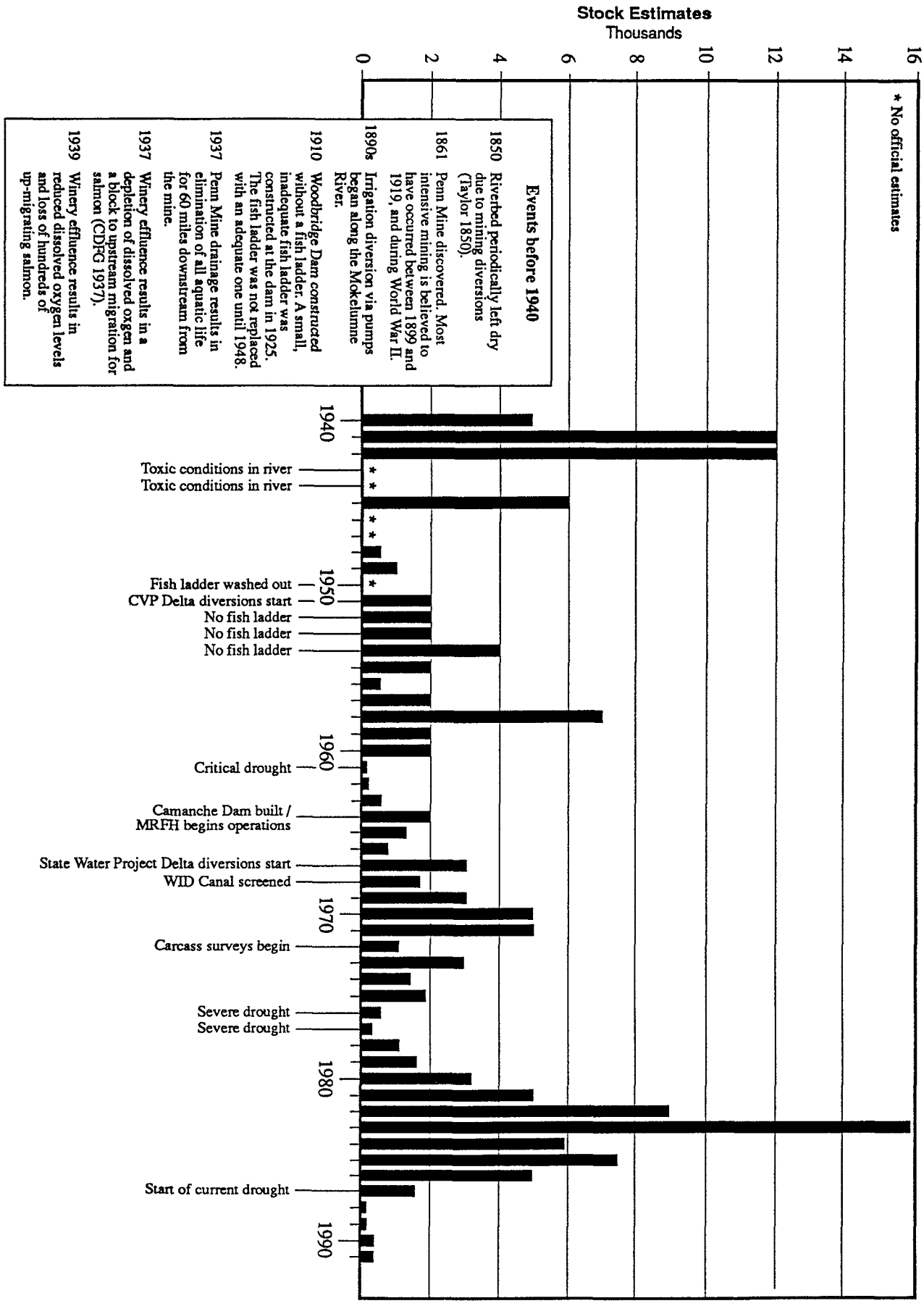

Figure 1. Mokelumne River salmon stock estimates and important environmental events, 1850-1991.

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The LMRMP has been in development for over two years. The plan incorporates feedback received during four public presentations to the EBMUD Board of Directors and numerous meetings with EBMUD management and technical staff and resource agencies. The goal of these meetings was to incorporate all operational and other constraints in the development of a feasible, efficient, and balanced plan.

In support of the development of the LMRMP, extensive reviews of literature were completed, unpublished data were obtained and analyzed, and extensive field studies were conducted. Much of this information is summarized in Section 3.0 and the appendices to this report. Table 1 lists modeling and field studies conducted in support of the plan.

Table 1 Field and modeling studies conducted in support of the LMRMP.

ISSUE	STUDY
Temperature, dissolved oxygen, and hydrogen sulfide	Development and application of a SNTEMP model for the Lower Mokelumne River Development and application of WQRRS models for Lake Lodi and Camanche Reservoir Water temperature monitoring Thermal refugia surveys
Habitat	Aquatic habitat between Pardee Dam and Camanche Reservoir Aquatic habitat between Camanche Dam and Lake Lodi Survey of salmonid rearing habitat below Woodbridge Dam
Fish Production	Invertebrate studies Emergence surveys Rearing fry surveys, 1990-1992
Biodiversity	Warmwater fish surveys below Woodbridge Dam
In-migration/Attraction	Adult in-migration monitoring 1990-1991
Spawning	Survey of chinook salmon redds in the Lower Mokelumne River, 1990-1992 Quality and quantity of spawning habitat for chinook salmon in the Lower Mokelumne River Fry emergence studies, 1991-1992
Production/Migration	Fry and smolt out-migration monitoring, 1990-1992
Mortality	River and Delta mortality, 1990-1992
Temperature/Migration	Effects of water temperature on timing of out-migration
Migration/Production	Effects of the timing of spawning and out-migration on overall smolt production
Habitat/Temp/Interaction	SCIES model
Escapement/Production/ Harvest	Life Cycle model

Many alternative flow and other management alternatives were analyzed and rated based on this evidence (Section 4.0). A plan proposed by the CDFG (CDFG 1991) was also evaluated as an alternative. The other alternatives involved different strategies for hatchery production, different flow strategies, and management to increase harvest and escapement. Many structural and other non-flow alternatives were evaluated. This extensive process resulted in the selection of the natural production alternative (the LMRMP) as the preferred plan.

THE PLAN

The LMRMP is an important commitment affecting EBMUD's water development and planning needs. Under the plan, EBMUD is committed to protecting the aquatic resources of the Mokelumne River by modifying reservoir operations and providing adequate water releases, making structural and operational improvements at the MRFH and Camanche and Pardee Reservoirs, providing leadership and participation in non-flow enhancement measures, and continuing monitoring and research.

The goals of the LMRMP include the following:

- Maintain water supply reliability by minimizing unnecessary storage releases using intensive monitoring and real-time management.
- Sustain and enhance fisheries benefits, especially salmon and steelhead trout, and other aquatic and riparian resources.
- Recognize and reduce uncertainty and develop new opportunities through a comprehensive and flexible monitoring and research program.

The LMRMP is sensitive to EBMUD's water supply and the needs of the fishery. Although the plan does not provide optimum flows for fish in all years, it provides a balanced approach that uses operational and non-operational measures linked to continuing monitoring and research. Unavoidable water shortages in dry years would be shared by people and fish. However, the plan will require an increase in the use of stored water to enhance the fishery resources. The plan is a balanced approach that uses a variety of measures to ensure long-term improvement of the aquatic environment and dependent species, while maintaining a reliable and high quality water supply source for EBMUD customers.

The LMRMP will increase natural and hatchery salmon production with a goal of establishing a distinct Mokelumne River chinook salmon run. The plan is specifically designed to increase returns to the river while maintaining current levels of ocean harvest. The plan includes reservoir operations and minimum flows for salmon spawning, rearing, and out-migration. It also will implement non-flow measures and improved research and monitoring to increase survival of salmon and steelhead trout. Also, the plan would determine why there is no significant steelhead run in the river, and would take steps to re-establish it.

The LMRMP incorporates flexibility and real-time management responses to monitored environmental conditions. It recognizes that management capability and strategy may change, and it prescribes monitoring and research requirements to allow the LMRMP to be modified as the information base is improved or management goals are changed. It recognizes the uncertainty inherent in any proposed plan developed for managing a unique and complex living system.

The LMRMP can be summarized in more detail under four topics: Camanche and Pardee reservoirs, the MRFH, the Lower Mokelumne River, and non-flow options, monitoring, and research. Summaries of these topics are presented below.

Camanche and Pardee Reservoirs Operations

EBMUD reservoirs are important to resident and downstream fisheries. Water quality in the reservoirs affects flow and non-flow measures of the LMRMP, and the LMRMP can affect water quality through its effects on storage. Generally, it is believed that the LMRMP would not substantially impact reservoir fisheries in comparison to current conditions.

General Strategy - Simulation model runs and other analyses indicated that water quality for the MRFH and river releases can be preserved if an adequate hypolimnetic (cold water) volume can be maintained in Camanche Reservoir. It is asserted that Pardee Reservoir hypolimnion may become unstable at a volume of less than 100,000 acre-feet (A. Horne pers. comm. 1992).

As part of the general strategy, stratification in Pardee Reservoir will be maintained by holding a minimum pool of 100 TAF in all but the driest of years. Stratification in Camanche Reservoir is expected to be preserved by maintaining a 28 TAF hypolimnion until the fall turnover. Releases from Pardee will be used to maintain the Camanche hypolimnion unless Pardee storage falls below 100 TAF, in which case releases to maintain stratification in Camanche will cease. Oxygenation of the Camanche hypolimnion would also be used to improve water quality in the reservoir and downstream.

Mokelumne River Fish Hatchery

General Strategy

Management of the MRFH emphasizes improved survival of fish produced, while protecting naturally-spawned fish in line with the long-run goal of developing a distinct Mokelumne River run. The LMRMP calls for the annual production of 1.66 million fall-run chinook smolts, 800,000 fall-run chinook yearlings, and 53,000 steelhead yearlings. In addition, the MRFH will provide production capacity for 2 million smolts, 47,000 anadromous steelhead yearlings, and 450,000 catchable steelhead as enhancement features (Table 2).

The MRFH Master Plan, prepared by EBMUD, includes the following water quality control measures:

- Control hatchery water temperature, as needed, by various means including the possibility of installing chilling and pre-chilling systems, ground water, and other temperature improvements to control hatchery water temperature and minimize solar related increases.

- Maintain dissolved oxygen levels with aeration and gas stabilization of the hatchery water supply and re-aeration of water in second pass of raceways.

Table 2. Proposed production goals and constraints at the Mokelumne River Fish Hatchery.

	Number	Target Size	Release Constraints
Mitigation			
Steelhead			
Anadromous	23,000	4/lb expected	Feb-Mar best
In-river	30,000	3/lb minimum	After July 1
TOTAL	**53,000**		
Chinook			
Smolts	1,660,000	60/lb minimum	May optimum
Yearling	800,000	10/lb minimum	Oct 15-31
Smolts (natural)[1,2]	125,000	6/lb expected	Nov.
TOTAL	**2,585,000**		
Enhancement[3,4]			
Four pumps steelhead	20,000	4/lb	Feb-Mar
Smolts	2,000,000	30/lb minimum	May optimum
Anadromous steelhead	47,000	4/lb expected	Feb-Mar best
Nimbus steelhead	450,000	6/lb expected	Oct 15-31
TOTAL	**2,517,000**		

[1] This component was added in late 1991 and is not included in the life cycle analysis. These smolts would be collected at fish traps in dry and critical dry years.
[2] These are tentative and are currently under discussion with CDFG.
[3] Mix of Mokelumne and imported smolts depends on MRFH production.
[4] Not the responsibility of EBMUD, funded through commercial salmon stamp revenues.

- Supply oxygen to maintain dissolved oxygen levels.

- Apply potassium permanganate as needed to neutralize hydrogen sulfide.

The MRFH Master Plan also includes:

- Increased production capacity by providing additional rearing space.

- Segregated rearing units for isolating and managing separate stocks (i.e., Mokelumne stock, imported stock, coded wire tagged groups).

- Improved rearing units to facilitate feeding and cleaning operations and result in improved hygiene conditions and healthier fish.

EBMUD would commit to funding the mitigation portion of the hatchery costs.

Lower Mokelumne River Flow

General Strategy - The LMRMP streamflow strategy recognizes natural variability in streamflow and adaptability of fish to withstand periodic drought conditions. Minimum flows were based on temperature and habitat requirements and water availability. All minimum flows were derived from BioSystems stream temperature modeling and CDFG flow/habitat studies. The LMRMP provides good conditions for all life stages with optimum conditions in normal and wet years except when major flood control releases are required which may be detrimental to the habitat if continued for an extended period. In addition, hydrologic and temperature simulations indicate that LMRMP temperature goals are violated and temperatures are problematic in about 4 years in 70. However, hatchery temperature would be protected by non-flow measures in these years. Minimum streamflows under the LMRMP are provided in Table 3.

Water year type, for the purposes of LMRMP minimum flows, is determined by considering Mokelumne River runoff and combined Pardee and Camanche reservoir storage. In May through October, normal and wet year flows are provided if projected 5 November Camanche and Pardee storage is equal to or greater than the maximum levels allowed, and dry year flows are provided if storage is projected to be below the maximum 5 November level allowed by the U.S. Army Corps of Engineers (COE). Critical dry year flows are provided if projected Pardee plus Camanche storage is 260 TAF or less, depending on adjustments for flood control credits from PG&E upstream reservoirs of up to 70 TAF. In November through April, year type is based on the prior, known 5 November storage using the same allowable storage levels.

Recommended Mokelumne River minimum flows as provided in Table 3 are based on temperature and habitat requirements balanced with water availability. Different flows are provided for different year types.

In-migration and Spawning

- Wet/Normal: flow released (from Camanche) to provide 100 percent of optimum spawning habitat.
- Dry: flow released to provide 80 percent of optimum spawning habitat.
- Critical Dry: flow released to provide 50 percent of optimum spawning habitat. Minimum passage flows provided below Woodbridge Dam.

Fry and Juvenile Rearing

- Optimum flow (balanced with spawning flows and out-migration flows) provided in all years without flood releases.

Out-migration

- Wet/Normal: flow released to provide suitable temperature conditions for out-migrants through June. Out-migrants trucked past Lake Lodi and Delta through July (1% of migrants).

- Dry: flow released to provide suitable temperature conditions for out-migrants through May. Out-migrants trucked past Lake Lodi and Delta through July (50% of migrants).

- Critical Dry: flow released to provide suitable temperature conditions for out-migrants to Lake Lodi. All out-migrants trapped and trucked past Lake Lodi or returned to hatchery for rearing.

Water temperature during the fall upstream migration and spawning period is determined by the temperature of Camanche releases, air temperature, and other weather conditions. Flow management during this time of year has little impact on downstream temperature, so habitat requirements guide LMRMP minimum flows.

No short term fall flow increases are proposed for attraction of adults because the effectiveness of such flows has not been conclusively demonstrated. Even if attraction flows above those identified in Table 3 were effective, it is likely that they attract stray fish to the river. This result would be inconsistent with the goal of establishing a distinct Mokelumne River chinook salmon run.

Table 3. Minimum flows (cfs) for Camanche and Woodbridge reaches.

Date	Camanche Reach Flows (cfs)				Woodbridge Reach Flows (cfs)			
	Critical Dry	Dry	Normal	Wet	Critical Dry	Dry	Normal	Wet
15 Dec-31 Mar	100	200	200	200	50	100	100	100
1 Apr-15 Apr	100	100	100	100	20	100	100	100
15 Apr-30 Apr	100	100	100	100	20	150	150	150
1 May-15 May	100	100	100	100	20	300	300	300
15 May-1 Jun	100	100	100	100	20	400	400	400
1 Jun-30 Jun	300	300	300	300	20	20	500	500
1 Jul-15 Jul	100	200	450	450	20	20	20	20
16 Jul-31 Aug	100	200	200	200	20	20	20	20
1 Sep-15 Oct	100	100	100	100	20	20	20	20
16 Oct-31 Oct	100	200*	300*	300*	20	100*	200*	200*
1 Nov-15 Dec	100	200*	300*	300*	100	200*	300*	300*

*As soon as optimum water temperatures are reached, the scheduled migration and spawning flows will be provided.

In any month, if spills are required, flows will be increased to wet year levels and reduced back to previous levels after flood control space is evacuated. Possibly, flood space evacuation releases and spills can be managed to provide additional fishery benefits, but this potential must be investigated with further research.

Hourly flow fluctuations were not explicitly addressed by the LMRMP. Such fluctuations should be minimized to the extent possible during spawning and rearing periods by avoiding operating criteria such as power generation during peak periods of the day, which has not historically been practiced at the Camanche Power Plant. For other than flood control releases, controllable daily streamflow reductions during the spawning and incubation period should not exceed 50 cfs per day. During other life stages, streamflow can be reduced by up to 100 cfs per day. Reductions in flood control release flows will be minimized by advanced planning, if possible, and releases will be spread over the summer months. However, this may not be possible as the reservoir operates in conformance with COE requirements. This may require substantial releases during winter and spring periods. Camanche storage can be predicted with reasonable accuracy in spring, well in advance of the early November reservoir space requirements.

Non-flow Strategies

In addition to operations, release flows, and MRFH recommendations, the LMRMP includes suggested non-flow components deemed important for improving the river fishery. A variety of non-flow alternatives were analyzed that could improve conditions for spawning, water quality in the lower river, and survival of juvenile fish. The measures selected as part of the LMRMP are:

- Reduced fishing activity during spawning and rearing
- Improvement of spawning substrate
- Creation of berm areas and breaking up embedded sediments
- Creation of spawning habitat for use during high-flow years when river spawning gravels are not usable
- Reduced rainbow trout stocking at certain times
- Construction and operation of a smolt trapping and tagging facility upstream of Lake Lodi
- Work with other water users to reduce entrainment
- Providing assistance for improved enforcement of fish and game laws

Improved enforcement of poaching laws, reduced instream angler encroachment onto spawning redds, and improved "take" regulations would be recommended for CDFG action.

Monitoring and Research

The LMRMP incorporates a continuing monitoring and research component to determine whether conditions of the LMRMP are being met, to provide needed information to improve

fishery management decisions, and to allow for modification of stated goals to better meet the LMRMP objectives (Section 6.0). These activities include:

- Monitoring water temperature, water quality, and weather
- Conducting population surveys for important fish species and survival estimations
- Performing additional water quality modeling work
- Monitoring in and out-migration

Steelhead monitoring and management would be focused to determine why a steelhead run has not developed, and then to establish a viable run.

COMPARISON OF CDFG AND LMRMP

The plan put forward by CDFG (1991) to optimize the Mokelumne River fishery was analyzed. Some substantive problems with that plan include:

- Little or no consideration of high mortalities in Lake Lodi or the Delta during out-migration
- Recommendations do not agree with results of their field studies
- Temperature goals are unattainable during important periods based on SNTEMP modeling
- The stated goal of increased recreational activity and access is inconsistent with improved river salmon survival
- High unpredictable flows will impact CDFG plan and the LMRMP
- Emphasis on a put-and-take steelhead trout fishery is inconsistent with anadromous steelhead escapement
- During dry periods, there is little sharing of limited water supplies and EBMUD supplies are substantially reduced. In about 10 percent of years, EBMUD would not be able to utilize Mokelumne River water supplies and, in several years, fisheries might be adversely affected by depletion of Pardee storage.

The CDFG Plan is not always consistent with its own technical findings. The Plan provides inadequate justification for flows which will require a large amount of water. Overall, it does not propose a balanced allocation of limited water supplies. CDFG did not have a water quality model or an operations model available to evaluate their reservoir operations and flow strategy. Under the LMRMP, water supply impacts have been considered, especially during dry and critically dry years when there is not a sufficient supply to meet all municipal, agricultural, and fishery needs.

The CDFG Plan and the LMRMP have both been analyzed to determine the effect of their implementation on the Lower Mokelumne River fishery and water supply (see Section 5.0). Using EBMUD's EBMUDSIM hydrologic model, operations studies have been performed to determine the flows available for the fishery and deficiencies to EBMUD customers when meeting the LMRMP and CDFG plans. The two plans are compared in Table 4.

Simulated Habitat and Population Effects

The Stream Corridor Inventory and Evaluation System (SCIES) (an integrated habitat model) and the Life Cycle Model (LFCYLE) (a population simulation model) were utilized as tools to evaluate the EBMUDSIM results of CDFG and LMRMP alternative flows. Estimated habitat values for salmon are similar under the two alternatives, but fry and juvenile rearing scores are better under the LMRMP while spawning and out-migration scores are better under the CDFG Plan.

In dry years, the LMRMP would employ trapping, tagging, and trucking to avoid adverse effects of elevated water temperatures. Under the CDFG Plan in dry years, although good out-migration conditions are provided in May, conditions are not conducive to high survival during June.

The chinook salmon frequency distribution of combined average SCIES scores indicates that there are more higher scores under the LMRMP than under the CDFG Plan, but differences in water temperatures in the two plans due to differences in reservoir storage were not considered.

The habitat values for steelhead are similar to chinook salmon except that the rearing conditions are much worse for steelhead than for chinook salmon under either plan. Fry and juvenile rearing for steelhead would be better under the LMRMP for dry and normal years than under the CDFG Plan. The frequency distribution of the combined average SCIES scores for steelhead show more higher scores under the CDFG Plan than for the LMRMP.

Table 4. Comparison of LMRMP and CDFG Plan

	LMRMP	CDFG
Reservoir Operation	Reservoir operations balanced between Pardee and Camanche (with temperature control in all but 4 years)	Camanche kept high, drawdowns relegated to Pardee. Pardee drawn down below 100,000 could result in temperature control problems in about 50% of 70 simulated years.
Year-type Water	Based on storage and hydrology	Based on annual hydrology
Year-type Frequency	Based on runoff and storage; EBMUDSIM projection is: critical 16%, dry 34%, normal 36%, wet 14%	Based on runoff; historic record is: dry 14%, normal 47%, wet 39%
River Habitat		
Spawning	Chinook: 100% of maximum WUA in wet and normal years; 80% in dry years; and 55% in critical years	Chinook: 100% of maximum WUA in wet and normal years; 80% in dry years
Rearing	100-200 cfs; 80-100% of maximum WUA	200-450 cfs; 82-54% of maximum WUA
Out-migration	Flow to control temperature through June in normal and wet years and through May in dry years; trap and truck at other times	Reservation of 10,000 af in wet and 5,000 af in dry years for short duration releases. Flows not enough for temperature control in dry years; no trap and truck
Hatchery	Salmon smolts To Delta 3.2 mil. To river 460,000 Salmon yearlings To river 800,000 Steelhead trout 73,000	Salmon smolts To Delta 2.0 million To river 0 Salmon yearlings To river 1.5 million Steelhead trout 100,000
Population Simulation (Chinook)	Smolts to Delta 431,000 Smolts past Chipps Island 3.0 mil. Harvest (ocean) 73,000 Escapement 8,400 + (multiplier) (1.7) Sustains populations and saturates habitat	Smolts to Delta 568,000 Smolts past Chipps Island 1.7 million Harvest (ocean) 60,000 Escapement 13,000 + (multiplier) (2.6) Sustains population and saturates habitat
Water Supply, 2020	Need for additional water 130,000 Acre-feet	720,000 Acre-feet
Customer Deficiency	Water not available from Mokelumne River for water supply 0%	10%
Frequency of Deficiency	50% or greater 1.5% 25% or greater 1.5% Some shortage 34%	50% or greater 20% 25% or greater 47% Some shortage 64%